Chemical Simulation of Organisms for Class Use

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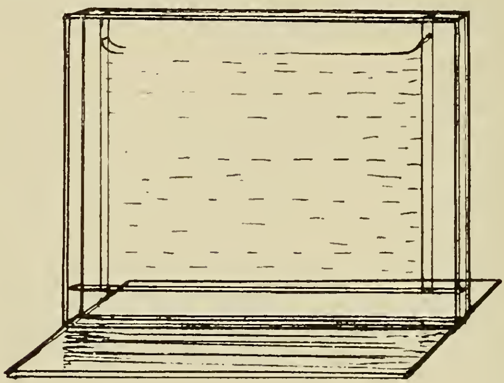
To enliven the student's interest and arouse his curiosity in plant and animal form development excellent opportunities are given the teacher in the hitherto neglected chemical imitations of organisms. Many beautiful and suggestively similar imitations of leaves, roots, stems, fern fronds, fungi, wing patterns of butterflies, bird feathers, a variety of sea life, algae, shells, corals "fairy rings," cell shapes, division figures, and countless other organic forms and patterns can be easily made with a little experience in the appropriate mixing of certain chemicals. Such imitations as have been made by Liesegang (1911), Küster (1913), Leduc (1912), and Gebhardt (1912) are stimulating and suggestive not only to the investigator but also to the students in elementary biology for whom they should be as instructive as entertaining.

The student can with simple apparatus and a few chemicals perform the experiments himself or they may be made by the teacher as demonstrations. The student can see before his eyes the production of forms and patterns in inert substances by some of the same processes which take place in and control the growth of organisms.

Just a few of the possible demonstrations are given below as suggestive of what can be done. Many other striking imitations can be devised by an imaginative teacher either by modifying or elaborating the directions given or by using other chemical combinations many of which may be found in the appended literature list. The materials and apparatus are inexpensive and can be employed with little expenditure of time.

Very beautiful imitations of fern fronds which are striking in their similarity may be made with certain crystalline precipitates in colloid solutions. A small plate of window glass, cleaned photographic plates, or lantern slide covers are very satisfactory. The plate is coated with a thin ten percent solution of gelatine containing five cc. each of saturated solutions of ammonium chloride and sodium chloride. The salts will crystallize out over night in various patterns many of which are similar in appearance to the outline of the fronds of selaginallas and ferns. (Figs. 3 and 5).

For the preparation of imitations of striped patterns, pigmentation of butterfly and bird wings, banded structure of ice, agate, onyx, quartz, etc., zonation in the molluscan shell, fish scales, mammalian bone, zebra and other hair patterns and banded leaves, concentric zonation in bacterial and fungous cultures, the chemically produced Liesegang rings may be used. Small glass plates similar to those described above are covered with a thin coating of ten percent gelatin solution containing one percent or less of Potassium bichromate or Sodium arsenite and then a drop of concentrated silver nitrate solution or a small crystal is placed where the center of the concentric rings is desired. With a little ingenuity the position of the silver may be varied by making lines and other combinations so that the various patterns enumerated above may be made.



Exhibition case constructed of lantern slide covers. Appearances such as are shown in figure 4 may be represented in such a glass box.

Very beautiful and fantastic tri-dimensional structures of calcium phosphate and carbonate imitative of ornamental diminutive gardens, suggestive of sea bottoms containing, shells, algae, and corals; the well known coral fungus, roots, rhizoids, stems and branches, carpophores, etc. will form in the solution described below. Tests tubes, beakers, vials, aquarium jars or any glass receptacles are satisfactory. I have found that a very entertaining little narrow glass box can be made of two lantern slide cover glasses between which strips of plate glass are cemented around the margins with a water proof glass, cement or bee's-wax. The exhibition jar is filled with a mixture made up of 50 cc. saturated solution of sodium carbonate, 25 cc. saturated solution of dibasic sodium phosphate, and 50 grams of calcium silicate. When the liquid is fairly clear small pieces of calcium chloride are dropped to the bottom of the jar. In from one to several hours the forms will arise from the chloride particle (Figs. 1, 2, and 4). The structures may attain a height of from a few to thirty or more centimeters. Their growth can be checked and varied by carefully adding distilled water. By very slowly moving the solution, branching and other variations may be induced. When the desired structures are completed the liquid may be slowly siphoned off, they are sufficiently hard and rigid to stand by themselves in the air but are very brittle and must be handled with care. Some of the aqueous cytological stains if carefully poured over the bottom will add to the attractiveness of the preparations. Carmine or light green will diffuse to the tops of the structures without altering their form.

If in the above preparations a very dilute solution of the same mixture is added after the mimic organisms are formed bladder-like enlargements will "grow" at the tips and increased resemblance to plant forms may thus be obtained (Figs. 1 and 4).

Other three dimensional imitations can be made by dropping a mixture of equal parts of sugar and copper sulphate crystals into a warm solution made up of 100 cc. distilled water, 10 grams gelatine, 10 cc. saturated solution potassium ferrocyanide (yellow) and 10 cc. saturated solution of sodium chloride. Tree-like trunks and branches, roots, leaves, and bud imitations are formed. When the gelatine solidifies the preparation is permanent and may be preserved and transported without injury.

Attention should be drawn to the possibilities in soap bubbles for a study of contact and pressure relations in cell form. Soap bubbles as is well known exhibit identical forms to those of massed cells in a parenchyma. A square glass jar, about quart size or larger, can be filled with soap bubbles by pouring into it a little soapy water and then blowing into this with a glass tube. The importance of surface tension and the principle of minimal areas, mutual contact and pressure in the control of cell form can here be pointed out. It can be shown to the student that in a froth as well as in massed cells the walls meet in groups of three at 120 degree angles, that the cells average six sides in section and fourteen altogether in response to the principle of minimal areas.

Drops of dilute india ink on gelatine covered plates diffuse in all directions giving a variety of patterns which also simulate organic forms. By placing two drops side by side and a more concentrated one between them imitations of nuclear divisions in various stages, showing asters, spindles, centrosomes, and chromosomes may be obtained.

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Description of Plate

Fig. 1. Imitations of fleshy fungi produced in crystalline solutions. The enlargements at the tips appeared when the mixture was diluted.

Fig. 2. Test tube preparation. The same substances were used but in more concentrated mixtures.

Fig. 3 and 5. Imitations of fern like growths crystallized from solutions of Ammonium and Sodium chlorides.

Fig. 4. Preparation made in the exhibition jar shown in the text figure.